2 QUALITY ASSURANCE DENSE GRADED AGGREGATES

Producer's Responsibility - Quality Assurance Program

The Producer shall furnish and maintain a plant laboratory, meeting the requirements of Section 106.07 of the Road and Bridge Specifications.

Test and Equipment

Test procedures shall be conducted in accordance with the standards referenced in the current specifications. Testing for Gradation, Atterberg Limits and cement content (where required) will be conducted. To accommodate the testing requirements, a field or plant laboratory shall be furnished and contain the following equipment:

1 - Motorized screen shaker for fine and coarse grading analysis.

1 - Set of sieves for the motorized shaker. The screen sizes shall include the specification sizes for the type of material being produced.

1 - Balance having a capacity of at least 45 lbs. (20 kg), with a sensitivity of one ounce (28 grams) or less.

1 - Balance having a capacity of at least 2.5 lbs. (1 kg), with a sensitivity of 0.1 gram or less.

1 - Drying apparatus.

1 - Set of liquid and plastic limit devices.

Under the QA program, a certified technician must be present at all times during the mixing of the final product. Such technician shall be capable of designing, sampling, testing and adjusting the mixture.

Sample, using an approved random method, and test in accordance with the Specifications. A rate of 4 samples per 2000 ton or 4000 ton lot shall be used. The specification requires that samples be obtained from the approximate center of truckloads of material or from a mini-stockpile. A statistically acceptable method of randomization is to be used to determine the time and location of the stratified random sample to be taken. The Department shall be advised of the method to be used prior to start of production.

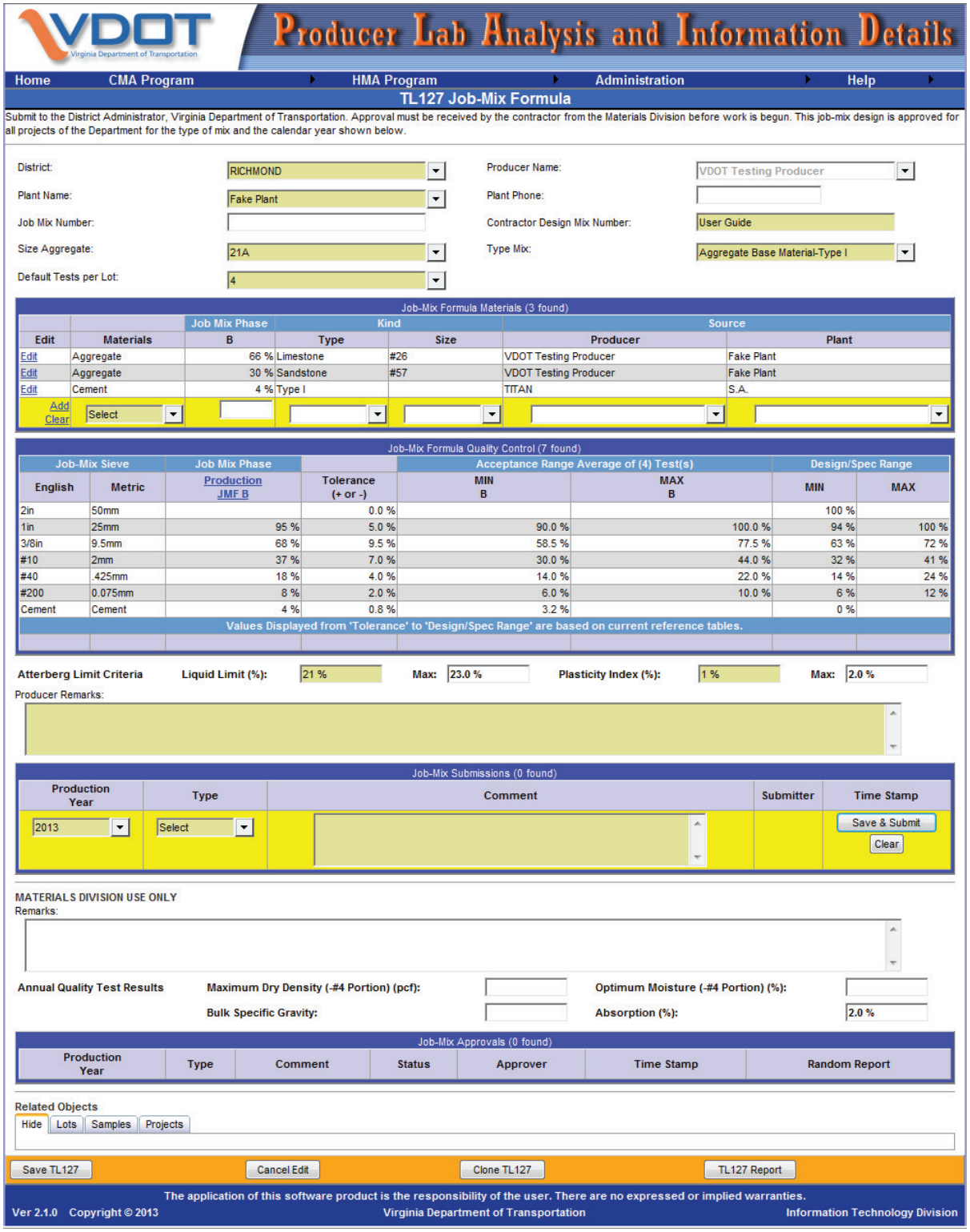
Record test results and maintain quality control charts that are kept visibly posted. Furnish the Department copies of the test results on forms furnished by the Department and maintain current control charts at the plant for review by the Department. Maintain all records and test results associated with materials production (e.g. hydraulic cement, etc.).

Notify the District Materials Engineer when production is to start or resume after a delay.

Obtain a sample at the request of the monitor and analyze half of the sample. The Department will analyze the other half. This sample shall be quartered or processed through a sample splitter in accordance with standard procedures. This sample will be used as the next production control sample. Properties to be determined include, but are not limited to, Gradation, Atterberg Limits, Cement Content and Moisture Content for subbase, aggregate base material, and select material. Form TL-52, which is available on the "Producer Lab Analysis and Information Details" (PLAID) website https://plaid.vdot.virginia.gov, shall be used by the producer to report these test results. The following information shall be provided on the TL-52 for each sample:

- District, Production Year;
- Producer Name, Plant Name;
- Size Aggregate, Mix Type, Job Mix Number;
- Lot Number, Sample Number, Sample Date, Sample Time, Sampled by, Tonnage;
- Project Number, Producer Lab location and Tested by.
- Route Number and Locality Code are (optional).

Such test results and information shall be entered and submitted by the producer within 48 hours of sampling through the PLAID website. Appropriate quality control charts shall be maintained at the plant.



VDOT Virginia Department of Transportation

Producer Lab Analysis and Information Details

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TL127 Job-Mix Formula

Submit to the District Administrator, Virginia Department of Transportation. Approval must be received by the contractor from the Materials Division before work is begun. This job-mix design is approved for all projects of the Department for the type of mix and the calendar year shown below.

District:	RICHMOND	Producer Name:	VDOT Testing Producer
Plant Name:	Fake Plant	Plant Phone:	
Job Mix Number:		Contractor Design Mix Number:	User Guide
Size Aggregate:	21A	Type Mix:	Aggregate Base Material-Type I
Default Tests per Lot:	4		

Job-Mix Formula Materials (3 found)

		Job Mix Phase	Kind		Source	
Edit	Materials	B	Type	Size	Producer	Plant
Edit	Aggregate	66 %	Limestone	#26	VDOT Testing Producer	Fake Plant
Edit	Aggregate	30 %	Sandstone	#57	VDOT Testing Producer	Fake Plant
Edit	Cement	4 %	Type I		TITAN	S.A.
Add Clear	Select					

Job-Mix Formula Quality Control (7 found)

Job-Mix Sieve		Job Mix Phase		Acceptance Range Average of (4) Test(s)		Design/Spec Range	
English	Metric	Production JMF B	Tolerance (+ or -)	MIN B	MAX B	MIN	MAX
2in	50mm		0.0 %			100 %	
1in	25mm	95 %	5.0 %	90.0 %	100.0 %	94 %	100 %
3/8in	9.5mm	68 %	9.5 %	58.5 %	77.5 %	63 %	72 %
#10	2mm	37 %	7.0 %	30.0 %	44.0 %	32 %	41 %
#40	.425mm	18 %	4.0 %	14.0 %	22.0 %	14 %	24 %
#200	0.075mm	8 %	2.0 %	6.0 %	10.0 %	6 %	12 %
Cement	Cement	4 %	0.8 %	3.2 %		0 %	

Values Displayed from 'Tolerance' to 'Design/Spec Range' are based on current reference tables.

Atterberg Limit Criteria — Liquid Limit (%): 21 % Max: 23.0 % — Plasticity Index (%): 1 % Max: 2.0 %

Producer Remarks:

Job-Mix Submissions (0 found)

Production Year	Type	Comment	Submitter	Time Stamp
2013	Select			Save & Submit / Clear

MATERIALS DIVISION USE ONLY

Remarks:

Annual Quality Test Results — Maximum Dry Density (-#4 Portion) (pcf): — Optimum Moisture (-#4 Portion) (%): — Bulk Specific Gravity: — Absorption (%): 2.0 %

Job-Mix Approvals (0 found)

Production Year	Type	Comment	Status	Approver	Time Stamp	Random Report

Related Objects: Hide | Lots | Samples | Projects

Save TL127 | Cancel Edit | Clone TL127 | TL127 Report

The application of this software product is the responsibility of the user. There are no expressed or implied warranties.

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Note: Detailed information about how to complete this form (TL 127) can be found in the PLAID user guide.

Department's Responsibility

District Materials Engineer's Staff and Independent Assurance (IA) Program

The term "Department Monitor" shall mean either a Department employee or contract personnel hired by the Department to conduct the monitor sampling.

1. Provide classroom or self-study technical instruction, examination and certification for all appropriate personnel.
2. Inspect the plant before production for compliance with specification requirements governing plant and testing equipment.
3. In the case of aggregates, furnish Proctor results (maximum dry density and optimum moisture content) to the Producer.
4. Perform unannounced periodic inspections of plants during production, including that of stockpiles, equipment, weighing operations, sampling, testing, and records kept by the Producer's technician.
5. Keep a diary of plant visits, observations and comments made to the Producer's representative.
6. Accept the product in accordance with the specifications, based upon the Producer's test results, provided such results are statistically comparable (VTM- 59) to the Department's monitor test results, and provided the material passes a visual examination for contamination and segregation at the job site. The sole purpose of the IA sample taken by the Department is to verify the accuracy of the producer's testing program. If the comparison indicates the IA test results are not in agreement with the Producer's results, an investigation will be made to determine the cause of difference. If the differences can be determined, the material will be accepted, adjusted or rejected in accordance with the specification. If the difference cannot be explained, the Department may call for the referee system to determine the final disposition of the material. In the event it is determined that the contractor's test results are not representative of the product, the Department will take such action as it deems appropriate to protect the interest of the Commonwealth.
7. Provide a referee system which may be invoked at the request of the producer or Department and which will involve use of test results obtained from samples secured from the road.

8. Independent Assurance samples are those obtained at the central mix aggregate plant by the Producer's Certified Central Mix Aggregate Technician in the presence and under the observation of the VDOT Materials Representative, and tested in the VDOT Laboratory or by AMRL- accredited consultant laboratories. These samples are tested for gradation, Atterberg Limits, water content, and cement content (if applicable). IA samples shall be obtained at a rate that both provides a statistically significant number of samples for each mix produced and allows verification of unstable mixes. At least one (1) IA sample shall be obtained and tested from each lot and as necessary to ensure statistical significance and to monitor unstable or nonconforming mixes. Unstable mixes are those that exceed variability tolerances provided in VTM-59.

Lot size shall be chosen, upon request by the Producer or District Materials Engineer and at the discretion of the District Materials Engineer, from either 2000 or 4000 ton lots. Lots shall be chosen in order to match Producer shipping rates, to reduce unnecessary testing, when past performance indicates stability, and when lot size/shipping rates are appropriate to ensure statistical significance will be obtained.

This rate of IA sampling is mandatory and it is the responsibility of the District Materials Engineer to see that it is accomplished. Should the IA effort fall behind the required frequency of sampling and/or testing, the District Administrator is to be advised immediately. Sufficient manpower is to be provided for the monitoring effort.

The Department's IA Technician will observe the manner in which sampling is performed by the producer. Not only is the when, where and how of taking the sample important but also the care taken to properly reduce the sample to testing size. The IA Technician directs when the sample shall be taken. They shall observe the producer's technician taking and splitting the sample. The IA technician takes 1/2 of the sample to a lab of their discretion for testing. The producer's technician will perform the test on the other half, which is to be considered as the next production sample for the producer.

During the time of the IA Technician's visit to the plant, they will pick up the District Materials Engineer's copy of the daily summary sheets. The forms are reviewed for correctness and legibility.

The CMA Point Adjustment Analysis Report, E12-1710-01 (Ch. 2 page 18)) will be produced by the VDOT Materials Representative. The report should be reviewed for correctness. The report shall be put in the District Materials Engineer's project folder. In the case of non-conforming materials a copy may be sent to the prime contractor. The material notebook only requires a one line entry identifying the period of time over which the material was shipped (Fr._____To_____), gradation or type mix, total tonnage and source. In case of non-conformance to the specifications, a copy of the test report will be furnished to the Prime Contractor by VDOT.

The success of the quality assurance program will be determined to a large extent by the effectiveness of the IA sampling and testing effort. Deficiencies revealed through this effort shall be addressed promptly and decisively. The results of the IA tests are recorded in the VDOT Material Information Tracking System (MITS). The MITS is capable of performing all of the statistical analyses required by VTM-59. Thus, this statistical test shall be made by the VDOT IA Technician immediately when the data is available, that is, after gradation results for a single lot's split sample are available from both the Producer and VDOT.

D2S Test - The D2S test is an individual test comparison between the Producer's results and VDOT's results on their respective splits of the IA sample. The D2S comparison is the individual test percent difference between two (2) results obtained on test portions of the same material. The figures for acceptable range of two (2) results, in percent, applicable for all sieve sizes, are those found in Table 2 – Estimates of Precision of AASHTO Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates, T 27-06, for multi-laboratory precision for coarse aggregate, and are listed below:

Total Percentage of Material Passing		Acceptable Range of Two Results (D2S), Percent
100	≥95	1.0
<95	≥85	3.9
<85	≥80	5.4
<80	≥60	8.0
<60	≥20	5.6
<20	≥15	4.5
<15	≥10	4.2
<10	≥5	3.4
<5	≥2	3.0
<2	0	1.3

In the event that for a given sieve, the total percentages of material passing obtained by the Producer and VDOT fall into different brackets, the acceptable range to use for the D2S test shall be that corresponding to the bracket designated by the job mix formula for the given sieve.

The benefit of performing the D2S test immediately upon the results of the IA sampling of a lot of material is that if discrepancies are found between the Producer's results and VDOT's results the reason for the discrepancies can be immediately investigated and remedied and material quality problems minimized. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given in Paragraph (d) below.

Matched Comparison Test - The IA tests performed by the MITS are made in a matched comparison report that compares the results of gradation, Atterberg Limits, and cement content tests (if applicable) of the Producer against those of VDOT on the split (matched) samples on a given job mix for a given plant using the VTM-59 methodology. The frequency of these reports shall be adjusted by the District Materials Engineer according to production schedule. The report shall use dates that include at least seven (7) IA results, if possible. Also, if there is a change in the production mix, the report shall begin with the date of the change. The report shall flag those values that are outside the statistically accepted range for samples collected from the same production operation. The report shall be reviewed by VDOT for correctness and one copy sent to the Contractor/Producer by way of a Materials Representative. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given below.

Verification Samples and Tests

Separate verification samples are not collected. The VST tests performed by the MITS are made in a non-matched comparison report that compares the results of gradation, Atterberg Limits, and cement content tests (if applicable) of the Producer against those of VDOT using the VDOT portion of the split sample and the non-split (non-matched) QC samples of the Producer on a given job mix for a given plant using the VTM-59 methodology. The frequency of these reports
shall be adjusted by the District Materials Engineer according to production schedule. The report shall use dates that include at least seven (7) IA results, if possible. Also, if there is a change in the production mix, the report shall begin with the date of the change. The report shall flag those values that are outside the statistically accepted range for samples collected from the same production operation. The report shall be reviewed by VDOT for correctness and one copy sent to the Contractor/Producer by way of a Materials Representative. When flags occur in which the data generated from VDOT's non-matched IA samples is indicating the material may not be within specification limits but the data generated from the Producer's non-matched QC samples is indicating the material is within specification limits, a thorough investigation shall be conducted. If the results are not in agreement, an investigation shall be made to determine the reasons for differences as given below.

Material Acceptance

Material is accepted in accordance with specifications, based upon the Producer's test results, provided such results are statistically comparable (per VTM-59 and as described below) to VDOT's IA and VST test results and provided the material passes a visual examination for contamination and segregation at the project site.

In the event a statistical comparative analysis of the Producer's quality control test results and VDOT's IA or VST test results indicate a statistically significant difference in the results, or either of the results indicate that the material does not conform to the gradation and Atterberg Limits requirements of the specifications, an investigation shall made to determine the reason for the differences.
Suggested checks are:

(1) Check to see if the IA test results meet the specifications for Average and Standard Deviation and the Producer's result on the mate of the IA sample to see if the two results are comparable (i.e. when flags occur from non-matched comparison test).

(2) Check to see if one of the systems is indicating a trend (consistently fine, coarse, erratic, etc.)

(3) Check sampling and testing procedure.

(4) Check testing equipment.

The results of the investigation shall be sent to the State Materials Engineer for use in preparing the annual report to FHWA, and to the Producer for their records. The sampling and testing procedures and laboratory test equipment (both the Producer's and the Materials Representative's) shall be checked as necessary. If the differences can be determined, the material shall be accepted, adjusted, or rejected in accordance with the specification. If differences still cannot be explained, then either the Producer or VDOT may call for the referee system to determine final disposition of the material. If it becomes necessary to implement the referee system, refer to Secs. 207.06 and 208.07 of the VDOT Road and Bridge Specifications to determine the sampling and testing details. If it is determined that the Producer's test results are not representative of the product, VDOT shall take such action as it deems appropriate to protect its interests.

The Project Inspector and the Quality Assurance Program

It is imperative that close communication be maintained between the Project Inspector and the District Material Engineer's staff and/or monitor Technician.

By the end of the next working day, the bonded weighperson will send the Weighperson Daily Summary Sheet to the Project Inspector, who will check the tonnage of material shipped against the total tonnage obtained from the weigh tickets, noting any loads that were not received, totaling the tonnage of those loads not received; add the tonnage deleted to the tonnage of material that was received, compare total tonnage to that indicated by the weighperson, and sign the verification statement. The Project Inspector should notify the producer or contractor of any differences in tonnage. Record in the Material Notebook general location, date and tonnage, with a note stating "QA".

Also, particular note should be made by the Project Inspector of any loads that appear to have required an abnormal transit time. These loads should be noted on the Weighperson Daily Summary Sheet. Time is very critical in the case of hydraulic cement stabilized aggregates. There is a 60 minute time limit between the start of mixing and the time that compaction of the hydraulic cement treated mixture begins.

Should visual examination reveal that the material in any load is contaminated or segregated, that load will be rejected without additional sampling or testing of the lot as specified in Section 208.06 of the Road and Bridge Specifications.

The Project Inspector shall retain the Weighperson Daily Summary Sheet, attach the corresponding weigh tickets to it, and keep it in the project files until completion of the project. At the completion of the project, the Project Inspector will forward the summary sheets and attached weigh tickets to the District Office together with other project records.

Material Acceptance QA Program--Specifications

The Producer shall have a CMA Technician present at the plant during the initial set up and during subsequent production. The Technician shall perform sampling, testing, designing and adjusting mixes as needed.

Sampling and testing for the determination of gradation, liquid limit and plasticity index shall be performed by the Producer, and the Department will perform independent IA checks. The Producer shall submit such test results to the Department through the TL-52 form which is available on the PLAID website https://plaid.vdot.virginia.gov. . VDOT's lab technician will enter test results of IA samples using the same form through the MITS website https://mits.vdot.virginia.gov. If the

Producer's test results indicate the material produced meets the appropriate requirements, the material will be accepted for use.

However, in the event a statistical comparison of the Producer's test results and the IA test results indicates a statistically significant difference, an investigation will be made to determine the reason for differences. If it is determined that the material does not conform to the requirements of the contract, appropriate price adjustments will be made.

Normally, acceptance for gradation, liquid limit, plasticity index and hydraulic cement content(when aggregate is to be stabilized) will be based upon a mean of the results of 4 tests performed on samples taken in a stratified random manner from each 2000 or 4000 ton lot. Monitor samples (also called Independent Assurance (IA) samples) shall be obtained at a rate that both provides a statistically significant number of samples for each mix produced and allows verification of unstable mixes. One (1) monitor (IA) sample shall be obtained and tested from each lot and as necessary to ensure statistical significance and to monitor unstable or nonconforming mixes. Unstable mixes are those that exceed variability tolerances provided in VTM-59.

A lot will be considered acceptable for gradation if the mean of the test results is within the deviation allowed from the job-mix formula shown in Table II-10.

A lot will be considered acceptable for Atterberg Limits if the mean of the test results is less than the maximum allowed for the liquid limit and plasticity index as shown in Table II-11.

Because the type of 75µm (minus 200) fines significantly affects the load bearing capacity of aggregate materials, there is a one point control on each individual sample run. In the event the liquid limit exceeds 30; the plasticity index exceeds 6 for Type I base material or the plasticity index exceeds 9 for Type II base material or subbase material No. 21A, 21B or 22 on any individual sample; that portion of the lot from which the sample was taken will be considered a separate part of the lot and shall be removed from the road, unless otherwise directed by the Engineer.

There is also a one point control on hydraulic cement stabilized material. If an individual test result indicates that the cement content of the material represented by the test is deficient by more than 1.6 percent from the design cement content, the portion of the material represented by the sample will be considered a separate part of the lot and shall be removed from the road.

Instances which cause a lot to be less than the normal size are: the contract requires less than acomplete lot; the job-mix formula is modified within a lot; a portion of the lot is rejected on thebasis of the one point controls mentioned above; or the final lot of the year produced on the annual job mix is less than a complete lot. In any of these events the mean test results of the samples taken will be compared to the requirements of Table II-10 and Table II-11 for the number of tests performed.

It is important to remember that acceptance of gradation and Atterberg Limits for Central Mixed Aggregates and Select Material, Type I is normally based on the average of 4 test results. Anything else is an exception, such as those previously mentioned. It is equally important to remember that the samples must be chosen randomly - each ton of each lot must have an equal chance of being sampled. The when and where of each sample must be chosen solely by chance, not by the sampler!

Specification requirements of Select Material, Type I, are found in Section 207 of the VDOT Road and Bridge Specification Manual; for Central Mixed Aggregate Bases and Subbases in Section 208; cement stabilized aggregates in Section 307.

Acceptance of Dense Graded Aggregates

Statistical Quality Assurance Program

In modern concepts of materials control and acceptance, a means has been adopted by the Department, by which the Producer can exercise product control while the Department can exercise product acceptance. The tool that enables this be accomplished is the Statistical method. Those who have not been exposed to statistics quite often are fearful of the term, but it should not be confusing. Statistics is simply a mathematical analysis of accumulated data. Statistical quality control is not complicated. We now accept or reject material on the average of test results in lieu of accepting or rejecting on an individual basis.

Stratified Random Sampling

An important phase of any acceptance or rejection plan is the process of “sampling”. The samples are selected using statistical systems requiring that “samples be taken in such a manner that every part of the quantity of material to be checked for compliance has an equal chance of being sampled”; that is, that the samples be taken randomly.

Another important phase of any acceptance or rejection plan is the quantity of material to be checked for compliance with specifications. In Statistical Quality Control, the term “lot” is used to denote the quantity of material to be checked for compliance with specifications, then accepted, rejected or subjected to price adjustment. 4 samples per 2000 ton or 4000 ton lot shall be used. IA samples shall be obtained at a rate that both provides a statistically significant number of samples for each mix produced and allows verification of unstable mixes. One IA sample shall be obtained and tested from each lot and as necessary to ensure statistical significance and to monitor unstable or nonconforming mixes. Unstable mixes are those that exceed variability tolerances provided in VTM-59. A statistically acceptable method of randomization is to be used to determine the time and location of the stratified random sample to be taken.

There are several acceptable methods for obtaining the 30-40 pounds of material required for testing. They are:

(1) Obtain a representative sample from the approximate center of the loaded truck.

(2) A loaded truck dumps at a convenient location within the plant facility to create a representative mini-stockpile. With the bucket of a front-end loader strike the top of the truck dumped load creating a flat spot on top of the pile from which a representative sample is obtained

(3) When the truck containing the load that is to be sampled is in the process of being loaded, remove a randomly selected front-end loader bucket of aggregate from the post pugmill shipping stockpile. Dump it at a convenient location within the plant facility creating a mini-stockpile. Strike the top of the mini-stockpile with the bucket of the front-end loader creating a flat spot from which to obtain the representative sample.

In order for a Plant Quality Control Technician to use Statistical Quality Control, it will be necessary to know: 1. When to take a sample? 2. Where to take a sample? 3. How to take a sample? 4. How to test the sample? 5. What to do with the test results?

Job-Mix Formula - Form TL-127 (see page 2-3)

The Producer shall submit a job-mix formula for each mixture for the Engineer's approval through the PLAID website. Form TL-127, which is available on the PLAID website, shall be used by the producer to submit to the District Materials Engineer (DME) a proposed mix using column B, before production begins and there-after in time to be approved by January 1 each subsequent year. Once submitted, the TL127 shall be reviewed by the DME through the "Materials Information Tracking System" (MITS) website https://mits.virginiadot.org and approved (or rejected) upon completion of review. Each approved design will be assigned a design number by the DME and remain in effect until a new mix design is submitted.

Small changes in quantities for gradation adjustment, etc. are not considered sufficient reason for a new mix design. A separate design must be submitted for any significant changes made. Approximately one week may be required for the evaluation of a new job-mix formula.

As previously stated, statistical systems use random sampling. Therefore, Statistical Quality Control of Central-Mix Aggregates utilizes random sampling of a lot. Virginia's Statistical Quality Control Program, however, goes one step further than just random sampling.

In Virginia, the stratified random sampling method is used. Stratified random sampling is sampling from equal portions of a lot at locations which have been selected solely by chance. Any statistically acceptable method of randomization may be used to determine the time and location of the stratified random sample to be taken; However, the Department shall be advised of the method to be used prior to beginning production. The following pages of this guide will describe and discuss step by step a procedure used in one stratified random sampling.

NOTE: The following is just one of many acceptable methods available, using a Random Number Table, and is presented here for instructional and examination purposes only.

Stratified Random Sampling

Step 1 - Determine lot size (2000 ton or 4000 ton lot). Lot size shall be chosen, upon request by the Producer or District Materials Engineer and at the discretion of the District Materials Engineer, from either 2000 or 4000 ton lots. Lots shall be chosen in order to match Producer shipping rates, to reduce unnecessary testing, when past performance indicates stability, and when lot sizes/shipping rates are appropriate to ensure statistical significance will be obtained.

Step 2 - Stratify Lot. (500 tons per sample for 2000 ton lot or 1000 tons per sample for 4000 ton lot.) Four samples per lot.

EXAMPLE:

One sample shall be on or between each group of tons shown below.

2000 ton lot	4000 ton lot
1 - 500	1 - 1000
501 - 1000	1001 - 2000
1001 - 1500	2001 - 3000
1501 - 2000	3001 - 4000

Step 3 - Secure four sets of stratified numbers from a Random Number table (page 2-15). The first number of each set can represent which ton is to be sampled.

Step 4 - Record these numbers. The Plant Quality Control Technician should notify the Weighperson.

Example for 2000 ton lot

Numbers selected
from Random No.
Table 1

Ton			Ton to be Sampled
0.192	1st sample	0 + (0.192 x 1000) =	192
0.432	2nd sample	500 + (0.432 x 1000) =	932
0.143	3rd sample	1000 + (0.143 x 1000) =	1143
0.214	4th sample	sample 1500 + (0.214 x 1000) =	1714

Example for 4000 ton lot

Numbers selected
from Random No.
Table 2

Ton			Ton to be Sampled
0.822	1st sample	0 + (0.822 x 1000) =	822
0.826	2nd sample	1000 + (0.826 x 1000) =	1826
0.495	3rd sample	2000 + (0.495 x 1000) =	2495
0.160	4th sample	sample 3000 + (0.160 x 1000) =	3160

Random Numbers Table 1

0.192	0.051	0.299	0.450	0.442	0.479	0.008	0.204
0.432	0.070	0.123	0.024	0.017	0.083	0.111	0.010
0.143	0.172	0.277	0.179	0.187	0.178	0.455	0.234
0.214	0.153	0.488	0.404	0.946	0.129	0.476	0.028
0.353	0.408	0.486	0.234	0.151	0.375	0.176	0.388
0.038	0.100	0.033	0.180	0.244	0.256	0.187	0.493
0.021	0.116	0.003	0.463	0.051	0.129	0.388	0.340
0.405	0.362	0.043	0.067	0.378	0.314	0.088	0.203
0.277	0.356	0.278	0.091	0.485	0.344	0.265	0.399
0.403	0.132	0.090	0.434	0.058	0.031	0.381	0.369
0.493	0.463	0.452	0.273	0.251	0.338	0.245	0.074
0.020	0.398	0.336	0.366	0.293	0.077	0.446	0.190
0.101	0.104	0.168	0.163	0.151	0.401	0.348	0.136
0.452	0.021	0.355	0.227	0.259	0.129	0.146	0.401
0.395	0.338	0.378	0.474	0.310	0.361	0.484	0.185
0.425	0.279	0.437	0.221	0.110	0.430	0.141	0.352
0.354	0.189	0.166	0.044	0.488	0.143	0.268	0.204
0.499	0.447	0.406	0.454	0.288	0.353	0.201	0.056
0.449	0.194	0.049	0.389	0.392	0.333	0.329	0.130
0.383	0.350	0.430	0.002	0.340	0.464	0.022	0.260
0.456	0.477	0.298	0.279	0.484	0.242	0.129	0.409
0.249	0.425	0.334	0.464	0.226	0.085	0.032	0.004
0.271	0.309	0.247	0.290	0.301	0.465	0.267	0.067
0.042	0.288	0.415	0.034	0.136	0.350	0.208	0.183
0.218	0.166	0.106	0.370	0.262	0.448	0.302	0.262
0.295	0.293	0.249	0.056	0.297	0.280	0.387	0.116
0.366	0.294	0.273	0.404	0.482	0.049	0.055	0.356
0.442	0.096	0.009	0.093	0.290	0.333	0.082	0.098
0.339	0.275	0.148	0.271	0.087	0.093	0.426	0.474
0.126	0.216	0.273	0.484	0.362	0.476	0.286	0.470
0.131	0.084	0.442	0.411	0.022	0.449	0.211	0.065
0.016	0.103	0.341	0.410	0.237	0.240	0.293	0.182
0.412	0.156	0.495	0.386	0.365	0.082	0.404	0.463
0.117	0.191	0.046	0.456	0.426	0.287	0.008	0.347
0.351	0.444	0.085	0.443	0.144	0.117	0.022	0.458
0.084	0.470	0.062	0.171	0.049	0.472	0.256	0.315
0.418	0.487	0.238	0.077	0.143	0.401	0.404	0.348
0.035	0.042	0.222	0.133	0.132	0.405	0.101	0.228
0.205	0.468	0.048	0.088	0.217	0.073	0.039	0.009
0.360	0.184	0.330	0.011	0.439	0.014	0.152	0.083
0.231	0.277	0.479	0.154	0.107	0.115	0.361	0.450
0.039	0.417	0.472	0.127	0.267	0.103	0.379	0.298
0.260	0.077	0.192	0.383	0.249	0.421	0.078	0.388
0.447	0.061	0.327	0.020	0.266	0.422	0.425	0.271

Random Numbers Table 2

0.822	0.640	0.703	0.511	0.152	0.282	0.617	0.298	0.012	0.136
0.826	0.995	0.295	0.654	0.388	0.495	0.610	0.406	0.397	0.648
0.495	0.449	0.278	0.666	0.734	0.372	0.076	0.508	0.001	0.046
0.160	0.450	0.782	0.748	0.075	0.187	0.035	0.206	0.094	0.753
0.379	0.192	0.370	0.558	0.088	0.330	0.321	0.166	0.610	0.084
0.558	0.255	0.178	0.936	0.521	0.941	0.597	0.906	0.868	0.483
0.452	0.627	0.190	0.301	0.172	0.979	0.363	0.297	0.943	0.968
0.278	0.402	0.386	0.562	0.319	0.940	0.314	0.621	0.406	0.014
0.003	0.738	0.048	0.629	0.806	0.721	0.858	0.509	0.999	0.168
0.429	0.828	0.597	0.642	0.873	0.839	0.607	0.262	0.612	0.413
0.508	0.878	0.152	0.263	0.991	0.868	0.621	0.265	0.960	0.646
0.223	0.441	0.283	0.432	0.527	0.941	0.919	0.731	0.322	0.302
0.838	0.412	0.307	0.176	0.647	0.377	0.806	0.240	0.240	0.792
0.892	0.269	0.041	0.362	0.116	0.758	0.805	0.600	0.728	0.955
0.558	0.990	0.066	0.325	0.587	0.173	0.540	0.778	0.689	0.126
0.962	0.033	0.186	0.881	0.934	0.367	0.845	0.171	0.396	0.965
0.052	0.407	0.705	0.925	0.354	0.889	0.709	0.040	0.809	0.576
0.642	0.129	0.172	0.009	0.040	0.743	0.388	0.156	0.626	0.699
0.034	0.813	0.748	0.474	0.138	0.594	0.120	0.940	0.456	0.787
0.709	0.949	0.024	0.520	0.082	0.583	0.861	0.151	0.899	0.451
0.301	0.523	0.705	0.380	0.162	0.364	0.842	0.434	0.884	0.927
0.598	0.671	0.639	0.549	0.783	0.617	0.805	0.125	0.808	0.297
0.138	0.433	0.339	0.062	0.691	0.232	0.554	0.703	0.270	0.396
0.310	0.716	0.387	0.597	0.631	0.494	0.511	0.265	0.275	0.404
0.074	0.488	0.760	0.630	0.970	0.670	0.463	0.506	0.164	0.568
0.191	0.485	0.476	0.295	0.579	0.103	0.501	0.917	0.330	0.816
0.851	0.319	0.543	0.211	0.054	0.088	0.063	0.546	0.494	0.511
0.400	0.199	0.953	0.643	0.082	0.873	0.647	0.647	0.971	0.537
0.166	0.144	0.177	0.775	0.671	0.981	0.172	0.549	0.157	0.047
0.909	0.124	0.327	0.267	0.178	0.839	0.174	0.509	0.538	0.641
0.942	0.600	0.039	0.994	0.153	0.825	0.590	0.895	0.352	0.676
0.543	0.931	0.129	0.018	0.812	0.460	0.323	0.862	0.842	0.324
0.493	0.855	0.268	0.126	0.090	0.568	0.717	0.714	0.711	0.007
0.117	0.524	0.961	0.716	0.769	0.741	0.149	0.504	0.399	0.304
0.846	0.604	0.749	0.429	0.546	0.105	0.309	0.531	0.478	0.363
0.733	0.753	0.932	0.919	0.990	0.332	0.227	0.656	0.831	0.778
0.687	0.169	0.109	0.587	0.541	0.957	0.209	0.589	0.871	0.772
0.764	0.856	0.074	0.797	0.419	0.064	0.366	0.391	0.412	0.414
0.854	0.744	0.431	0.823	0.778	0.839	0.726	0.371	0.207	0.527
0.533	0.044	0.366	0.346	0.792	0.396	0.103	0.513	0.586	0.968
0.076	0.639	0.187	0.013	0.579	0.410	0.826	0.286	0.257	0.956
0.222	0.959	0.743	0.654	0.240	0.219	0.072	0.336	0.465	0.667
0.912	0.667	0.534	0.355	0.708	0.220	0.865	0.695	0.531	0.623
0.732	0.359	0.816	0.984	0.554	0.414	0.425	0.461	0.293	0.708
0.736	0.320	0.535	0.227	0.650	0.542	0.380	0.099	0.822	0.619
0.069	0.545	0.362	0.488	0.198	0.351	0.747	0.923	0.192	0.145

Step 5 - Take the sample. The sample shall be taken from approximately, 150 mm(6 in.) to 300 mm (12 in.) beneath the surface of the mini-stockpile. (Strike off the top 150 mm (6 in.) of material and take the sample vertically.)

*Note: **Hydraulic Cement Stabilized Central Mix Aggregate.** The sample for the cement content and water content should be taken first and as described above. The cement flow to the aggregate should be stopped or cut-off and the sample for the gradation, L.L. and P.I. taken from the next load which would not have any cement in it. This load will not be shipped to a project. The procedure form sampling should be the same as described above.

Step 6 - Test the sample. (Gradation, Atterberg Limits, Moisture Content, and Cement Content if material is stabilized. The cement content is determined by the titration test method.)

Step 7 - Submit test results through the PLAID website. (Form TL-52, Materials Division Central Mix Aggregates Test Results Form). The Test Results Form will be discussed later in this class.

E12-1710-01
Rev 8/98

Virginia Department of Transportation
Materials Division
Central Mix Aggregate
Point Adjustment Analysis Report

Report Number:

Plant ID: 1009 Cardinal Stone Company, Galax, VA
Job Mix ID: 9701 Type Material: 79 Aggregate Base Material-Type I
Lot Number: 1 Size Material: 76 Subbase/Base Material-Size 21 A

Contract/Schedule Information

Contract Number	Item	Tonnage	Price
000330	0	2000	$0.00

Sample Information

Sample Number	Ton Number	Quad	Date	Time	75 MM (3")	50 MM (2")	25 MM (1")	19 MM (3/4")	9.5 MM (3/8")	2.0 MM (#10)	0.425 MM (#40)	0.075 MM (#200)	Liquid Limit	Plasticity Index	Moisture Percentage	Cement Content
1	350		02/04/2014	10:56	0.0%	100.0%	100.0%	0.0%	71.0%	25.4%	14.6%	6.7%	16.0%	0.0%	5.3%	0.0%
2	869		02/05/2014	08:32	0.0%	100.0%	100.0%	0.0%	65.0%	28.7%	18.5%	9.1%	17.0%	0.0%	5.2%	0.0%
3	1288		02/05/2014	12:25	0.0%	100.0%	100.0%	0.0%	55.1%	26.3%	16.8%	8.1%	16.0%	0.0%	5.1%	0.0%
4	1799		08/17/2014	09:12	0.0%	100.0%	100.0%	0.0%	68.3%	29.5%	18.8%	7.2%	16.0%	0.0%	5.1%	0.0%

Analysis of Mixtures

	75 MM (3")	50 MM (2")	25 MM (1")	19 MM (3/4")	9.5 MM (3/8")	2.0 MM (#10)	0.425 MM (#40)	0.075 MM (#200)	Liquid Limit	Plasticity Index	Moisture Percentage	Cement Content
Job Mix	0.0%	100.0%	95.0%	0.0%	63.0%	32.0%	19.0%	8.0%	21.0%	1.0%	4.0%	0.0%
Upper Limit	0.0%	100.0%	100.0%	7.0%	72.5%	39.0%	23.0%	10.0%	23.0%	2.0%	6.0%	NA
Average	0.0%	100.0%	100.0%	0.0%	64.8%	27.5%	17.2%	7.8%	16.0%	0.0%	5.2%	0.0%
Lower Limit	0.0%	100.0%	90.0%	0.0%	53.5%	25.0%	15.0%	6.0%	0.0%	0.0%	2.0%	NA
Pass / Fail (Process)												

Total Adjustment 0.0

E12-1710-01

11-sep-00

Virginia Department of Transportation
Materials Division
Central Mix Aggregate
Comparison Analysis Report

Plant ID: 1032 Tri State Lime Co., Blountville, TN
Job Mix ID: 1002 Subbase/Base Material-Size 21 B, Aggregate Base Material-Type I

	Lot Number	Sample Number	75 MM (3")	50 MM (2")	25 MM (1")	19 MM (3/4")	9.5 MM (3/8")	2.0 MM (#10)	0.425 MM (#40)	0.075 MM (#200)	Cement Content	Liquid Limit	Plasticity Index
Job Mix			0.0%	100.0%	95.0%	0.0%	64.0%	23.0%	12.0%	7.0%	0.00%	21.0%	1.0%
Plant Data													
	1	1	0.0%	100.0%	95.3%	0.0%	57.8%	18.8%	10.7%	7.0%	0.00%	10.8%	0.0%
	1	2	0.0%	100.0%	93.9%	0.0%	60.3%	19.8%	11.1%	7.2%	0.00%	0.0%	0.0%
	1	3	0.0%	100.0%	93.8%	0.0%	59.0%	19.8%	11.0%	7.4%	0.00%	14.2%	0.0%
	1	4	0.0%	100.0%	94.1%	0.0%	59.5%	21.8%	11.0%	7.1%	0.00%	0.0%	0.0%
	2	1	0.0%	100.0%	93.4%	0.0%	59.7%	21.3%	11.1%	7.1%	0.00%	11.5%	0.0%
	2	2	0.0%	100.0%	91.7%	0.0%	49.9%	16.9%	8.6%	5.6%	0.00%	0.0%	0.0%
	2	3	0.0%	100.0%	94.6%	0.0%	57.7%	20.0%	10.7%	6.7%	0.00%	12.9%	0.0%
	2	4	0.0%	100.0%	95.4%	0.0%	64.2%	24.0%	11.5%	7.2%	0.00%	0.0%	0.0%
	3	1	0.0%	100.0%	93.8%	0.0%	54.0%	19.8%	10.7%	6.9%	0.00%	12.0%	0.0%
	3	2	0.0%	100.0%	96.6%	0.0%	64.9%	25.6%	11.3%	6.7%	0.00%	0.0%	0.0%
	3	3	0.0%	100.0%	97.7%	0.0%	61.9%	24.9%	12.4%	7.4%	0.00%	14.2%	0.0%
	3	4	0.0%	100.0%	97.0%	0.0%	61.5%	24.5%	12.5%	7.5%	0.00%	0.0%	0.0%
	4	1	0.0%	100.0%	96.4%	0.0%	60.7%	23.7%	11.9%	7.0%	0.00%	16.0%	0.0%
	4	2	0.0%	100.0%	99.0%	0.0%	68.1%	23.0%	11.7%	6.9%	0.00%	0.0%	0.0%
	4	3	0.0%	100.0%	97.6%	0.0%	66.1%	22.3%	11.3%	6.6%	0.00%	14.9%	0.0%
	4	4	0.0%	100.0%	98.2%	0.0%	65.6%	22.6%	11.5%	6.9%	0.00%	0.0%	0.0%
	5	1	0.0%	100.0%	97.4%	0.0%	70.2%	25.5%	12.8%	7.5%	0.00%	12.7%	0.0%
	5	2	0.0%	100.0%	97.0%	0.0%	63.2%	22.0%	11.2%	6.8%	0.00%	0.0%	0.0%
	5	3	0.0%	100.0%	95.2%	0.0%	63.7%	22.1%	11.0%	6.5%	0.00%	14.9%	0.0%
	5	4	0.0%	100.0%	91.5%	0.0%	63.7%	22.6%	11.3%	6.5%	0.00%	0.0%	0.0%
Plant Data													
		Count:	20	20	20	20	20	20	20	20	20	20	20
		Mean:	0.0%	100.0%	95.5%	0.0%	61.6%	22.0%	11.3%	6.9%	0.0%	6.7%	0.0%
		Standard Deviation:	0.00	0.00	2.12	0.00	4.72	2.34	0.86	0.44	0.00	6.98	0.00
Monitor													
	1	1	0.0%	100.0%	96.0%	0.0%	55.8%	18.1%	10.0%	3.4%	0.00%	14.0%	0.0%
	1	2	0.0%	100.0%	94.4%	0.0%	63.0%	26.0%	13.5%	8.7%	0.00%	14.0%	0.0%
	1	3	0.0%	100.0%	92.2%	0.0%	48.0%	17.9%	10.0%	6.2%	0.00%	14.0%	0.0%
	1	4	0.0%	100.0%	93.8%	0.0%	49.4%	16.6%	8.9%	5.8%	0.00%	14.0%	0.0%
	2	2	0.0%	100.0%	92.0%	0.0%	48.4%	16.8%	8.9%	5.9%	0.00%	14.0%	0.0%
	3	1	0.0%	100.0%	94.3%	0.0%	55.4%	19.5%	10.7%	7.2%	0.00%	14.0%	0.0%
	3	2	0.0%	100.0%	97.4%	0.0%	64.4%	25.0%	10.4%	6.2%	0.00%	14.0%	0.0%
	3	3	0.0%	100.0%	98.9%	0.0%	65.3%	26.3%	11.9%	7.1%	0.00%	14.0%	0.0%
	4	1	0.0%	100.0%	97.8%	0.0%	66.8%	22.0%	10.7%	6.8%	0.00%	14.0%	0.0%
	5	1	0.0%	100.0%	96.7%	0.0%	67.9%	23.4%	9.9%	6.2%	0.00%	14.0%	0.0%
	5	4	0.0%	100.0%	98.3%	0.0%	66.0%	23.9%	9.2%	5.8%	0.00%	14.0%	0.0%
Monitor Data													
		Count:	11	11	11	11	11	11	11	11	11	11	11
		Mean:	0.0%	100.0%	95.6%	0.0%	59.1%	21.4%	10.4%	6.3%	0.0%	14.0%	0.0%
		Standard Deviation:	0.00	0.00	2.42	0.00	7.89	3.74	1.36	1.29	0.00	0.00	0.00
Report													
		(F):	0.00	0.00	1.31	0.00	2.79	2.56	2.48	8.56	0.00	0.00	0.00
		(F.99):	3.43	3.43	3.43	3.43	3.43	3.43	3.43	3.43 *******	3.43	3.43	3.43
		AM-AC:	0.0	0.0	0.1	0.0	2.5	0.6	0.9	0.6	0.0	7.3	0.0
		MU:	0.0	0.0	2.5	0.0	7.7	3.7	1.3	1.2	0.0	4.5 *******	0.0

CMA Comparison Analysis Report

Knowledge Check

Chapter 2 Quality Assurance/Dense-graded Aggregates Program

1. What determines the lot size for a specified material accepted under the Statistical QA Program?

   A. Production tonnage
   B. Discretion of the District Materials Engineer
   C. Size aggregate
   D. A and B

2. A normal lot is represented by how many test samples?

   A. 8
   B. 2
   C. 3
   D. 4

3. The Producer's Technician is responsible for making batch adjustments.

   A. True
   B. False

4. The job-mix formula is approved by the:

   A. Project Inspector
   B. Producer's Technician
   C. District Materials Engineer
   D. Resident Engineer

5. The Project Inspector is responsible for the submission of the job-mix formula.

   A. True
   B. False

6. One of the duties of the District Materials Engineer's CMA staff technician is to provide technical guidance to the Producer's Technician.

   A. True
   B. False

7. The inspection, sampling, and testing of the aggregates for conformance with the VDOT Specifications are the responsibilities of the:

   A. Project Inspector
   B. Weighperson
   C. Producer's Technician
   D. VDOT representative

8. Must the Producer's Technician in a plant producing Aggregate Base, Subbase and Select Material, Type I be a certified CMA Technicians?

   A. Yes
   B. No

9. When must the job-mix formula be submitted by the Producer?

10. How long does the Department have to evaluate a job mix formula change?

11. A system that allows resampling and retesting where there is doubt that the original test results are valid is the:

    A. Referee System
    B. Variability System
    C. Process Tolerance System
    D. Standard Deviation System

12. A chart that is set up to alert the Producer when to investigate his process is a Control Chart.

    A. True
    B. False

13. The job-mix formula for Aggregate Bases, Subbases, and Select Material, Type I is chosen from the:

    A. Standard Deviation
    B. Design Range
    C. Process Tolerance
    D. Acceptance Range

14. In the production of Cement Stabilized Aggregate, no one sample shall have a cement content more than 1.3 percent below that stated on the Job-Mix Formula.

    A. True
    B. False

15. Is it permissible to accept Central Mix Aggregate by visual inspection?

    A. Yes
    B. No

16. Who approves the source and quality of materials for use in Central Mix Aggregates?

17. Who is required to furnish a plant laboratory?

18. The job acceptance sample for central mix aggregate bases, subbases and select material is taken from:

    A. Conveyer belt
    B. Mini-stockpile
    C. Barge
    D. Truck

19. What is the difference in taking a sample of stabilized and non-stabilized material?

20. Does the Plant Quality Control Technician run job acceptance samples when the Producer is stockpiling?

    A. Yes
    B. No